INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY



S-E-C-R-E-T

50X1-HUM

COUNTRY USSR

REPORT

SUBJECT AM-9b Turbojet Engine Production Data

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seven pages of descriptive material on the Soviet turbojet engine AM-9b. The data are apparently part of the official Soviet specifications for the original engine and an improved model

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Chapter II

## BASIC TECHNICAL DATA FOR THE ENGINE AM-9L

### General Data

| | | |
|---|---|---|
| 1. | Designation | RD-9B* |
| 2. | Type of engine | Turbojet with afterburner |
| 3. | Compressor | Axial, 9 stage, with an automatic control mechanism for bleeding air from the 5th stage |
| 4. | Combustion chambers | Straight-through, individual, arranged within the engine casing |
| | a) Quantity | 10 |
| | b) Arrangement | Circumferential |
| | c) How numbered | From the left-hand upper chamber, counter-clockwise looking forward |
| 5. | Turbine | Axial, two stage |
| 6. | Jet nozzle | Adjustable in three positions |
| | Diameter of exit section of jet nozzle: | |
| | a) With afterburner operating, when starting and at an idling speed | 498 +to flange not less than 4 mm - 3 mm |
| | b) At maximum power | 442 + 7 mm |
| | c) at all other powers | 465 ± 7 mm |
| 7. | Direction of rotation | Counterclockwise looking forward |
| 8. | Over-all dimensions of the engine | |
| | a) Length including afterburner | 5555 mm |
| | b) Diameter at combustion chambers | 665 mm |
| | c) Diameter of afterburner | 636 mm |
| | d) Maximum height of engine including appended units | 938 mm |
| 9. | Dry weight | 695 kg + 2% |
| 10. | Guaranteed life up to first overhaul | 100 hours |

### Basic Operating Conditions [illegible]

| | | |
|---|---|---|
| 11. | With afterburner operating [Forsazhnyy Rezhim] | |
| | a) Rotor rpm | 11,150 ± 50 |
| | b) Temperature of the gas exhausting from the turbine**: | |
| | on the ground: | |
| | 1) for an ambient air temperature less than 15°C | not more than 650°C |

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| 2) for an ambient air temperature of 15°C or above in flight: | Not more than 680°C |
| 1) the max. temperature of turbine exhaust gases is set between limits of | 620 - 680 °C |
| c) Length of time for continuous operation: | |
| 1) Up to 6000 m | not more than 6 min. |
| 2) 6000 m and above | not more than 10 min. |
| 3) during climb | not more than 5 min. |
| 12. Maximum power [Maksimal'nyy Rezhim] | |
| a) Rotor rpm | 11,150 ± 50 |
| b) Temperature of the gas exhausting from the turbine: | |
| 1) on the ground | not more than 650°C |
| 2) in flight | not more than 680°C |
| c) Length of time of continuous operation | |
| 1) up to 6000 m | not more than 6 min. |
| 2) 6000 m and above | not more than 10 min. |
| 13. Nominal power [Nominal'nyy Rezhim] | |
| a) Rotor rpm | 11, 150 ± 50 |
| b) Temperature of the gas exhausting from the turbine | not more than 650 °C |
| c) Length of time of continuous operation | unlimited |
| 14. 0.8 nominal power | |
| a) Rotor rpm | 10,400 ± 50 |
| b) Length of time of continuous operation | unlimited |
| 15. Idling Speed | |
| a) Rotor rpm | 4100+200 (?) |
| b) Temperature of the gas from turbine | not more than 690°C |
| c) Length of time of continuous operation | not more than 10 min |
| 16. Acceleration | |
| a) Times for accelerating: | |
| 1) from idle to nominal power | 9 - 12 sec |
| 2) from idle to maximum power | 9 - 13 sec |
| 3) from idle to afterburner operation | not more than 15 (?) sec |
| 4) from MAR* to nominal power | 9 - 12 sec |
| b) Permissible temperature of turbine exhaust when testing acceleration | not more than 750 (?) °C |
| c) Permissible short duration (3 - 5 sec) overspeed when testing acceleration | not more than 11,600 rpm |
| d) Permissible short duration ( 3-5 sec) overspeed when cutting in and cutting out afterburner | not more than 11,600 rpm |
| e) Time from maximum power to afterburner operating | not more than 6 (?) sec. |

Remarks: Time for moving the engine control lever when testing acceleration at overspeed should be 1.5 - 2 sec.

*MAR is the rpm at which the "automatic regulation" begins to operate (Englis

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**Fuel System**

| | |
|---|---|
| 17. Type of fuel | |
| a) basic fuel for engine operation at all powers | Fuel T-1 (GOST 4138-49) or T5-1 (GOST 2149-54) (?) |
| b) Starting fuel for engine starting | pure aviation "Benzine" (GOST 1012-54) (?) |
| 18. Fuel pump | |
| a) Designation | TsN-9 |
| b) Type | Centrifugal, with constant pressure (?) valve |
| 19. Fuel pump-regulator unit for the basic fuel | |
| a) Designation | NR-10A |
| b) Type | Plunger, with an automatic device for metering fuel at all powers |
| c) The beginning of automatic regulation of rpm of the engine | 8200 ± 100 rpm |
| 20. Fuel pump-regulator unit for afterburner fuel | |
| a) Designation | NR-11A |
| b) Type | Plunger, with an automatic device for metering fuel as a function of flight conditions when operating with afterburner |
| 21. Fuel pressure before fuel pumps NR-10A and NR-11A | 1.6 - 2.6 kg/cm$^2$ |
| a) for brief intervals | up to 2.8 kg/cm$^2$ |
| 22. Main spray nozzle | |
| a) Type | Centrifugal, 2-channel |
| b) Quantity | 10 |
| 23. Afterburner spray nozzle | |
| a) Type | Centrifugal |
| b) Quantity | 17 |
| 24. Fuel pressure before main spray nozzles | not more than 80 kg/cm$^2$ |
| 25. Fuel pressure before afterburner spray nozzles | not more than 90 kg/cm$^2$ |

**Lubricating Oil System**

| | |
|---|---|
| 26. Type of system | Closed, individual, pressurized |
| 27. Type of lube oil | MK-8 (GOST 6457-53) or transformer oil (GOST 982-53) |
| 28. Lube oil consumption | not more than 0.5 kg/hr |
| 29. Lube oil pressure | |
| a) at idle | not less than 1 kg/cm$^2$ |
| b) at max. rpm | 4-4.5 kg/cm$^2$ |

Remarks: The above data is taken from test stand trials. Under flight conditions it is necessary to be guided by the readings of the lube oil pressure indicator 2BUU5-1.3-3 (See item 32).

| | |
|---|---|
| 30. Temperature of lube oil when entering the engine, at all powers | |
| a) Min. permissible | -40 °C |
| b) Max. permissible | 85 °C |
| 31. Lub oil pumps | |
| a) Pressure | |
| 1) Type | gear, single stage |
| 2) Quantity | 1 |
| 3) Output at nominal power with a back pressure of 3-4 kg/cm$^2$ and a lube oil temp. of 60-65°C | 25 liters/min |
| b) Scavenge pump | |
| 1) Type | gear, three sections |
| 2) Quantity | 1 |
| 3) Output at nominal power with a back pressure of 1.0 kg/cm$^2$ and a temp. of 70-75° C. | |

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| | |
|---|---|
| a) Section which pumps the lube oil out of the forward part of the engine casing. | 60 (?) liters/min |
| b) Section, pumping from the center bearing | 22 liters/min |
| c) Section, pumping from the rear bearing | 22 liters/min |
| 32. Two-stage lube oil pressure indicator | |
| a) Designation | 28DU5-1.3-3 |
| b) Type | membrane |
| c) Purpose | To close the signal light circuit when lube oil pressure drops below 1.3 atm. ( rror permissible: 0.3 atm.) when the air bleeding band is open; and below 3 atm. (error permissible -0.2 atm) when the air bleeding band is closed. |
| 33. Designation of the fuel-lube oil unit, consisting of lube oil tank, fuel-lube oil radiator and low pressure fuel filter | "agregat" 317A |
| a) Quantity of lube oil in lube oil tank: | |
| 1) Maximum | $7.5^{+0.5}$ liters |
| 2) Minimum for engine operation | 5 liters |

Starting System

| | |
|---|---|
| 34. System | Electric, automatic |
| 35. Starting fuel pump (installed in the aircraft) | |
| a) Designation | PNR-10-9M |
| b) Type | gear, with electric motor drive type MU-102A |
| c) Quantity | 1 for two engines |
| d) Starting fuel pressure when starting | 1.0 - 1.75 kg/cm$^2$ |
| e) Output at ground conditions, back pressure 2 kg/cm$^2$, voltage at terminals of electric motor 24V. and current 5A. | 40 liters/hr |
| 36. Starting spray nozzle | |
| a) Type | Centrifugal |
| b) Quantity | 4 |
| 37. Generator-starter | |
| a) Designation | GSR-ST-6000A |
| b) Purpose | Used as engine starter; Used as DC generator when engine is operating |
| c) Horsepower, as a starter | 3.5 hp at 24 volts and 200 amperes |
| d) Power, as a generator | 6000 watts at 30 volts |
| e) Length of time operating as starter | 44.5 $\pm$ 0.5 sec. (31.5 $\pm$ 0.5 sec in 24-48 volt system) |
| f) Permissible number of starting attempts, sequentially | 5, after which cool off for 30 min. |
| 38. Starting panel (installed in the aircraft) | PKS-6000E (for 24-48 volts, PKS-6000I) |
| 39. Automatic timing device for starting (installed in the aircraft) | AVP-1VB (for 24-48 volts, use AV5A) |

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|---|---|
| 40. Number of starts without changing: | |
| a) With 24-48 volt system using storage batteries 12SAM-12 | not less than 3 |
| b) With 24 volt system using one battery 12SAM-28 | not less than 3 |
| 41. Consumption of starting fuel per start | not more than 0.5 kg. |
| 42. Permissible exhaust gas temperature when starting | not more than 850°C |
| 43. Time to reach idling speed when starting | not more than 80 sec. (60 sec with 24-48 volt system) |

Ignition System, Electrical Equipment and Control

| | |
|---|---|
| 44. Type of igniter in the engine and afterburner | spark, intermittent |
| 45. Spark plug | |
| a) for the engine | |
| 1) type | KP-21B1M |
| 2) quantity | 1 |
| b) for the afterburner | |
| 1) type | KPM-1A |
| 2) quantity | 1 |
| 46. Starting flame holder | shielded |
| a) Type | ~~KP-50~~ |
| b) quantity | 4 |
| 47. Afterburner flame holder | |
| a) Type | SF-02 |
| b) Quantity | 1 |
| 48. Regulator for generator (installed in the aircraft) | |
| a) Custom regulator | R-25A |
| b) Differential-minimum relay | RNR-400 |
| c) Stabilizing transformer | T-18 (T-11?) |
| d) Ballast resistance | RB-6000 |
| 49. Box for the "automatics" of the afterburner (installed in the aircraft) | KAF-2 (for 24-48 volt system, KAF-2A) |
| 50. Mechanism for controlling the air bleeding band of the compressor | |
| a) Type | Hydraulic, piston, with a centrifugal valve and a solenoid valve. |
| b) Fuel pressure in the control system for air bleeding | not more than 85 kg/cm$^2$ |
| c) Centrifugal valve | Controls the band according to the rpm of the engine |
| d) Engine rpm at which the band opens | 9700 (-100) rpm |
| 51. Mechanism for controlling the jet nozzle flaps | |
| a) Type | hydraulic, piston |
| b) Number of driving cylinders | 4 |
| c) hydraulic fluid, designation | AMG-10 (GOST 6794-53) |
| d) Pressure in hydraulic system | 80-140 kg/cm$^2$ |
| e) Temperature of hydraulic fluid | -40°C to +60°C |

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52. Switches for the mechanism for controlling the jet nozzle flaps (installed in the aircraft)
   a) Designation — GA-21 (illegible)
   b) Type — slide valve, with electromagnetic control
   c) Quantity — 2 (on one engine)

53. Control panel
   a) Designation — PU-3 (?)
   b) Purpose —
   1) Cutting-in and cutting-out the afterburning and full power regimes;
   2) Drive for the nozzle flaps in the afterburning and nominal positions at 4500-6500 rpm, according to movement of the engine control lever to "STOP" or to "NOMINAL"
   3) Changing the phase of the lube oil pressure indicator 28ТУ5-1.3-3
   4) Permitting the turning over of the engine when cold, while the control lever is at "STOP"
   5) Switching over the electrical system when laying up or re-activating the engine

54. Safety and Interlock Equipment
   a) Low fuel pressure indicator for afterburner fuel manifold
      1) Purpose — SD-3 (?)
      To provide automatic cutting-out of the afterburning and maximum power regimes when fuel pressure falls below 0.3 kg/cm$^2$

   b) Low fuel pressure indicator for afterburner fuel manifold
      1) Purpose — DKD-2, membrane type
      1) To render impossible the opening of the jet nozzle flaps when cutting in the afterburner if the excess of pressure in the afterburner fuel manifold over thetotal pressure of the gases in the afterburner chamber is less than 0.2 kg/cm$^2$
      2) To render impossible the closing of the jet nozzle flaps when cutting out the afterburner if the excess of pressure in the afterburner fuel manifold over the total pressure of the gases in the afterburner chamber is greater than 0.2 kg/cm$^2$

   c) Hydraulic cut-out of fuel pump NR-11A (installed in the aircraft)
      1) Purpose — Type . . . 34. . . (illegible)
      To provide automatic cutting-out of the afterburner in case of loss of pressure in hydraulic system for operating jet nozzle flaps.

   d) Terminal switch for the hydraulic pressure release /didrazmeditel'/ on pump NR-10A
      1) Purpose — To render impossible the cutting-in of maximum power and afterburning regimes if engine rpm is less than 10,400 ± 200 when engine control lever is moved smoothly to these positions.

   e) Terminal cut-out "L" for the compressor air bleeding band
      1) Purpose — 1) To render impossible the opening of the jet nozzle flaps into afterburning position at altitudes where the idling rpm is greater than the rpm at which air bleeding occurs, when throttling down the engine.

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2) To render impossible the cutting-in of afterburning and maximum regimes at rpm's less than the rpm at which air bleeding occurs, when testing acceleration.

Aircraft Equipment /Samoletnyye Agregaty/

55. Hydraulic pump (installed in the space for equipment /Turbina Agregatov/ by the aircraft factory).
   1) Designation — 623 (gear type) or 435 BM (variable stroke plunger type)
   2) Quantity — 1

Instruments for Control

56. Tachometer (installed by the aircraft factory)
   a) Type — 2TE - 15 with indicator DT-3
   b) Quantity — 1 set (for one engine)

57. Thermometer for measuring gas temperature at turbine exit (installed by the aircraft factory).
   a) Type — TVG-11
   b) Quantity of thermocouples — 4, arranged in series

## SECTION I

## DIFFERENCES IN BASIC TECHNICAL DATA

The basic technical data for engine RD-9B of the sixth series correspond to those of the earlier produced RD-9B with the following changes, by sections:

General Data

| | |
|---|---|
| 1. Designation | RD-9B of the sixth series |
| 2. Jet nozzle, type | Adjustable in 3 positions |
| a) diameter of the exit section of the flaps when operating the afterburner, when starting and idling, up to 4500-6500 rpm | $^{+}$ to flaps not less than 4 mm<br>498 - 3 mm |
| b) At maximum power | 438 -452 mm |
| c) At nominal and transitional powers | 461-475 mm |
| 3. Engine attachment to the aircraft | To suit the customer |
| 4. Engine Equipment: | |

Engine is equipped with individual automatic starting which insures starting by pressing a single button; fuel pump-regulator combination NR-10AKB, which controls the engine and keeps the rpm constant at all altitudes and flying speeds, accelerates the engine by the control lever within 1.5 - 2.0 sec., and meters engine fuel during starting; fuel pump-regulator combination NR-11VA, which provides for automatic, step-by-step supply of fuel to the afterburner in an amount proportional to the ratio of the air pressure at the compressor exit to the gas pressure at the turbine exit ($P_2 - P_4$ = const). $P_2 \cdot P_4$ = const.

Also, an anti-icing apparatus for the intake duct, providing normal operation of the engine under all atmospheric conditions;

Also the afterburner and jet nozzle are fitted with an automatic system for supplying fuel and for opening the flaps of the nozzle.

5. The rpm of the upper limit of {pumping} on the aircraft is 9,250.

Basic Operating Conditions

| | |
|---|---|
| 6. With afterburner operating | |
| a) rpm | 11,150 $\pm$ 50 |
| b) Temperature of turbine exhaust gases | not more than 680°C |
| c) Engine rpm at which the maximum power regime and afterburning regime are cut out | 10,400 $\pm$ 200 |
| d) Length of time for continuous operation: | |
| 1) In flight | not more than 15 min. |
| 2) On the ground | not more than 10 min |
| e) Length of time of operation beyond permissible life before overhaul | not more than 10 hours |
| 7. Maximum power | |
| a) rpm | 11,150 $\pm$ 50 |
| b) Temperature of turbine exhaust gases | |
| 1) On the ground | not more than 650°C |
| 2) In flight | not more than 680°C |
| c) Length of time for continuous operation | |

| | |
|---|---|
| 1) Up to 6000 m | not more than 6 min. |
| 2) 6000 m and above | not more than 10 min. |
| d) Length of time of operation beyond permissible life before overhaul | not more than 5 hours |
| 8. Nominal power | |
| a) rpm | 11,150 ± 50 |
| b) Temperature of turbine exhaust gases | not more than 650°C |
| c) Length of time for continuous operation | unlimited |
| 9. 0.8 Nominal power | |
| a) rpm | 10,400 ± 50 |
| b) Length of time for continuous operation | unlimited |
| 10. Idling speed | |
| a) rpm | 4100 ± 200 |
| b) Temperature of turbine exhaust gases | not more than 650°C |
| c) Length of time for continuous operation | not more than 10 min. |

Remarks: At idling speed, and at other speeds with compressor air bleeding band in open position, continuous operation of the engine on the ground (on adjoining [Bestyhovannyi] aircraft) for up to 5 min. is permissible. If it is necessary to operate the engine for a longer period under the foregoing conditions, it is mandatory to increase the rpm to 9800 - 10,000 (or shut off the engine), and after holding it thus for one minute, continue operation at the desired condition.

| | |
|---|---|
| 11. Acceleration | |
| a) Times for accelerating: | |
| 1) from idle or MAR to nominal power | 11 - 14 sec. |
| 2) from idle or MAR to max. power | 11 - 15 sec. |
| 3) from idle or MAR to afterburner operation | not more than 18 sec. |
| b) Permissible temperature of turbine exhaust gases when accelerating | not more than 750°C |
| c) Permissible short duration (3-5 sec) overspeed when accelerating and when cutting-in the afterburner | not more than 11,500 |
| d) Permissible short duration (3-5 sec) overspeed when cutting-out afterburner | not more than 11,600 |
| e) Time from maximum power to afterburner operating ( a function of rate of increase of fuel pressure) | 5 - 8.5 sec. |

Remarks: The time for moving the engine control lever when testing the acceleration, during overspeed, and also when using throttled maximum regime and afterburning regime, up to 15,000 m, must be not less than 1.5 - 2 sec. When using throttled maximum and afterburning regimes, at an altitude of 15,000 m and above, this time must be not less than 5 sec.

Fuel System

| | |
|---|---|
| 12. Fuel pump-regulator unit for the basic fuel | |
| a) Type | NR-10AK3, plunger with automatic device for metering fuel at all powers |
| b) Direction of rotation | Right-handed (viewed from drive side) |
| c) gear ratio | 3.125 |
| d) Beginning of automatic regulation of rpm's | 9500-200 rpm |

13. Fuel pump-regulator unit for the afterburner fuel
    a) type — NR-11VA, plunger with an automatic device for metering fuel and its step-by-step supply to the afterburner combustor after cutting in the afterburner
    b) direction of rotation — Right-handed (viewed from drive side)
    c) gear ratio — 3.125

Lubricating Oil System

14. Lube oil pumps
    a) pressurizer
       1) Type — gear, single-sectioned, with quick-removal filter cover, with constant flow through the lube oil filter regulated by a tube with a 0.8 mm dia. jet
       2) Quantity — 1
       3) Direction of rotation — left-handed
       4) gear ratio — 4.00
       5) flow at nominal power with a back pressure of 4 0.2 kg/cm$^2$ and a temperature of 60-75°C — 23 liters/min
    b) Lube oil pumps at engine exits
       1) type — gear, three sections
       2) quantity — 1
       3) direction of rotation — left handed
       4) gear ratio — 2.590
       5) Flow at nominal power at a back pressure of 0.5 kg/cm$^2$ and temperature of 60 - 75°C:
          a) Section which pumps the lube oil out of the forward part of the engine casing [korpus] — 50 liters/min (?)
          b) Section, pumping from the center bearing — 25 liters/min
          c) Section, pumping from the rear bearing — 25 liters/min

15. Two-stage lube oil pressure indicator
    a) Type — 28D05-1.3-2.8
    b) Purpose — To close the signal light circuit when lube oil pressure drops below 1.3 atm (error permissible: 0.3 atm.) when the air bleeding bend is open; and below 2.8 atm. (error permissible: 0.2 atm.) when the air bleeding bend is closed.

16. Designation of the fuel-lube oil unit, consisting of lube oil tank, fuel-lube oil radiator and low pressure fuel filter — "agregat" 317A
    a) The radiator insures engine operation within the allowable lube oil temperature limits (not more than 85°C at inlet to engine) with a fuel temperature of not more than 40°C at inlet to radiator
    b) Quantity of lube oil in tank:
       1) Maximum — 10.5 - 11 liters
       2) Minimum for engine operation — 7 liters

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**Ignition System, Electrical Equipment and Control**

| | |
|---|---|
| 17. Afterburner flame holder | |
| a) Type | SD-108A with transitional device [Perekhodnik] P-11 |
| b) Quantity | 1 |
| 18. Regulator for the generator | |
| a) Carbon regulator | R-27 |
| b) Differential-minimum relay | DRR-400AM |
| c) Stabilizing transformer | T-10 (? T-11 ?) |
| d) Ballast resistance | BS-6000 |
| 19. Box for the "automatics" of the afterburner (installed in the aircraft) | KAF-5 |
| 20. Control Panel | |
| a) Designation | PU-9B |
| b) Purpose | 1) Cutting-in and cutting-out the afterburning and full power regimes;<br>2) Drive for the nozzle flaps in the afterburning nominal positions at 4500 - 6900 rpm, according to the movement of the engine control lever to "STOP" or "NOMINAL".<br>3) Checking the phase of the lube oil pressure indicator 2SUZ-1.3-2.8<br>4) Permitting the turning over of the engine when cold, while the control lever is at "STOP"<br>5) Reducing the engine rpm in maximum and afterburning regimes |
| 21. Safety and Interlock Equipment | |
| a) Low fuel pressure indicator for afterburner fuel manifold, DSD-2: | |
| 1) Purpose | 1) Renders impossible the opening the nozzle flaps when there is no fuel pressure in the afterburner fuel manifold<br>2) Renders impossible the closing of the nozzle flaps if pressure exists in the afterburner fuel manifold. |
| b) Hydraulic switch UG-3A.1: | |
| 1) Purpose | 1) Provides automatic cut-out of afterburner in case of loss of pressure in hydraulic control cylinders of the jet nozzle |
| c) Low fuel pressure indicator for fuel transfer system of the aircraft, type SD-3 | |
| 1) Purpose | Provides automatic cut-out of afterburning and maximum power when pressure in fuel transfer system falls below 0.2 kg/cm$^2$ |
| d) Terminal cut-out for the hydraulic release of pump NB-10AM: | |
| 1) Purpose | Renders impossible the cutting-in of afterburning and maximum power at rpms less than 10,900 100 when engine control lever is moved smoothly to "NOMINAL" |
| e) Terminal cut-out "L" for the compressor air bleeding band (located in control panel PU-9B) | |
| 1) Purpose | 1) Renders impossible the opening of the jet nozzle flaps into afterburning position at altitudes where the idling rpm is greater than the rpm at which air bleeding occurs, when throttling down the engine.<br>2) Renders impossible the cutting-in of afterburning and maximum power regimes at rpm's below the rpm at which air bleeding occurs, when testing acceleration |

## Aircraft Equipment /Samoletnoye Agregaty/

In the engine space the following units of aircraft equipment are installed:

| | | |
|---|---|---|
| 22. Hydraulic pump | | |
| a) Type | 435 BM | |
| b) Quantity | 1 | |
| c) Direction of rotation | right handed | |
| d) Gear ratio | 4.5 | |
| 23. Flanges for connecting air bleed off to cabin supercharger, flanges to fuel piping and flanges to anti-icing system are to be fitted | Quantity of air to be determined in agreement with aircraft plant | |

Remarks:

a) The direction of rotation given above for various units is the direction when looking toward the flange of the unit from the shaft side.

b) The gear ratio of the units is given by the formula

$$\text{gear ratio} = \frac{\text{rpm of the engine}}{\text{rpm of the unit}}$$

[redacted]